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(71) Applicant: THE DOW CHEMICAL COMPANY  
Dow Center 2030 Abbott Road Post Office Box 1967  
Midland Michigan 48640(US)

(72) Inventor: Mientus, Bernard S.  
880 Truman Court  
Newark Ohio(US)

(72) Inventor: Fields, William G.  
590 Deanna Stroll  
Heath Ohio(US)

(72) Inventor: Bussey, Marlin G.  
338 Deer Trail Drive  
Thornville Ohio(US)

(74) Representative: Hann, Michael, Dr. et al.  
Patentanwälte Dr. Michael Hann Dr. H.-G. Sternagel  
Marburger Strasse 38  
D-6300 Giessen(DE)

(54) Olefin polymer stretch/cling film.

(57) Olefin polymer films composed essentially of a copolymer of a major proportion of ethylene with a minor proportion of a higher  $\alpha$ -olefin monomer and an effective amount of a trackifying agent are provided which have unusually high Elmendorf tear strength in the machine direction, a good balance of machine direction to transverse direction Elmendorf tear strengths, and excellent cling properties. Such films are exceptionally well suited for use as a stretch/cling film in various packaging and palletizing applications.

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# OLEFIN POLYMER STRETCH/CLING FILM

The present invention relates to olefin polymer films and, in particular, to olefin polymer films having a combination of physical properties making them especially well suited for use as stretch/  
5 cling films in various packaging and/or palletizing applications. In another aspect, the present invention relates to biaxially oriented films of ethylene/higher  $\alpha$ -olefin copolymers having a tackifying agent incorporated therein.

10 In the packaging and/or palletizing art, it is known to package individual articles and/or to bundle together or palletize a plurality of articles using a so-called "stretch wrapping" technique. According to such technique, a relatively thin film web  
15 of a polymeric material is stretched or elongated, thereby creating tension in said film web, while being wrapped several times around the article or articles to be packaged or palletized. Upon the release of the stretching or elongating forces at the conclusion of  
20 the wrapping operation, the film attempts to relax or spring at least partially back to its original non-stretched dimension thereby tightly or snugly

engaging the article or articles wrapped therein. In connection with such a stretch wrapping operation, it is possible in theory to secure the stretched and wrapped film in place around the packaged article or articles in a variety of ways (i.e., so as to prevent the stressed or tensioned film from returning or relaxing back to its original dimensions without imparting the desired packaging integrity to the packaged article or articles encompassed thereby).

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10 However, as a matter of practical expediency, efficiency and economy, it is common practice to employ film which exhibits sufficient cling to itself to hold said film in place around the packaged article, to prevent significant slippage of the stretched overlaid film layers, and to thereby prevent relaxation or shrinkage of said film back to its original pre-packaging unstretched dimensions.

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While a variety of films are currently available on the commercial market for use in stretch/-cling packaging or palletizing operations, such currently available films all suffer from one or more notable deficiencies, drawbacks or limitations. For example, some of the films which are currently available are produced via cast film processes. While such cast films are typically characterized by having high Elmendorf tear ratings in the transverse direction, they also generally have relatively low tear resistance in the machine direction. As such, these cast films have a pronounced tendency to tear on the corners or at other sharp protrusions of articles being stretch wrapped or palletized therewith. On the other hand, certain other currently available stretch/cling films, such as those produced by conventional blown film

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processing techniques, generally have a more acceptable balance between their Elmendorf tear ratings in the machine and transverse directions, but are generally less than totally satisfactory in terms of certain  
5 other properties such as, for example, their cling properties, particularly at high degrees of elongation.

In view of the foregoing deficiencies of the stretch/cling films available to date, it would be highly desirable to provide a polymeric film having the  
10 proper combination of properties to overcome said deficiencies and to thereby be especially well suited for use as a stretch/cling film for packaging and palletizing end-use applications.

The invention relates to a stretch/cling film  
15 (A) having (a) an Elmendorf tear rating in the machine direction of at least 250 g/mil; (b) a machine direction:transverse direction Elmendorf tear ratio of at least 0.5; and (c) a cling value of at least 10 grams per 12.7 cm (5 inches) of sample width and  
20 (B) being composed of an olefin polymer composition consisting essentially of (a) an ethylenic copolymer comprising, in polymerized form, a major proportion of ethylene and a minor proportion of a higher  $\alpha$ -olefin monomer containing 6 or more carbon atoms and (b) an  
25 effective amount of a tackifying agent.

The stretch/cling films of the present invention are particularly notable and beneficial in the sense that they embody an overall combination of properties which has not heretofore been available  
30 with prior art stretch/cling films. For example, the machine direction Elmendorf tear strengths and the

MD:TD Elmendorf tear strength ratios of the subject stretch/cling films surpass those of conventional stretch/cling films made by known cast film processes and are thus especially well suited for use in the stretch wrapping bundling of articles having sharp edges or corners, or other sharp protrusions, associated therewith. The subject stretch/cling films also exhibit better surface smoothness and cling properties than has heretofore been achievable using internal tackifying agents in conjunction with conventional blown film manufacturing techniques.

The olefin polymer resins employed to make the stretch/cling films of the present invention are those ethylenic copolymers which comprise a major proportion by weight of ethylene copolymerized with a minor proportion by weight of a higher  $\alpha$ -olefin monomer containing 6 or more carbon atoms. Such ethylenic copolymers are commonly referred to in the art as linear low density polyethylenes (LLDPE). Preferably the ethylenic copolymers employed are those having from 2 to 10 weight percent of said higher  $\alpha$ -olefin monomer copolymerized therein. In addition, it is also preferable that the higher  $\alpha$ -olefin monomer employed in said ethylenic copolymer be a  $C_6$  to  $C_{12}$   $\alpha$ -olefin such as, for example, 1-hexene, 1-heptene, 1-octene, 1-nonylene, 1-decene, etc., and in particular, 1-hexene, 1-heptene or 1-octene.

While it is not especially critical, the aforementioned ethylenic copolymers employed in the practice of the present invention will typically have a melt index, as determined pursuant to ASTM-D-1238, Condition E, of from 1 to 10 (preferably from 1 to 5)

decigrams/minute and a density in the range of from 0.915 to 0.930 (preferably from 0.915 to 0.925) g/cc:

As has been previously alluded to, a particularly beneficial feature of the stretch/cling films of the present invention is that they possess relatively high Elmendorf tear strength in the machine direction as evidenced, for example, by machine direction (MD) Elmendorf tear strength values of at least about 250 g/mil (preferably at least about 300 g/mil) and by machine direction (MD) to transverse direction (TD) Elmendorf tear strength ratios of at least about 0.5 (preferably at least about 0.6). With regard to such features, experimental work conducted in connection with the present invention has revealed that the machine direction Elmendorf tear strength and MD:TD Elmendorf tear strength ratio of the subject stretch/-cling films are notably reduced when said films are prepared from blends of the above-described ethylenic copolymers containing as little as 5 weight percent (total polymer weight basis) of conventional low density polyethylene homopolymers admixed therein. Accordingly, it is believed to be an important aspect of the present invention that the polymer composition employed to prepare the subject stretch/cling films consists essentially of the above-defined ethylenic copolymers and an effective amount of a suitable tackifying agent.

Tackifying agents suitably employed herein are materials which when blended with the above-described ethylenic copolymers are capable of imparting increased tackiness or cling to at least one surface of a film prepared therefrom. By the phrase "increased tackiness

or cling" it is meant that at least one major surface of a film prepared from a polymer composition comprising the above-described ethylenic copolymer and the tackifying agent has a measurably higher cling than either major surface of a film prepared from a polymer composition which is identical thereto except for having none of the tackifying agent incorporated therein. Representative materials useful as tackifying agents herein include hydrocarbon resins such as terpene resins, hydrogenated resins and resin esters, isotactic and atactic polypropylenes, polybutenes and the like. Of particular interest in the practice of the present invention are atactic polypropylene and the polybutenes, particularly polymers of isobutylene. The isobutylene polymers preferably employed have a relatively low molecular weight, i.e., a number average molecular weight less than 3000, more preferably from 500 to 2500, wherein molecular weight is determined by gel permeation chromatography. Alternatively, the preferred atactic polypropylenes have a number average molecular weight of up to 5000, more preferably from 2000 to 4000. Most preferably, the tackifying agent is polyisobutylene having a number average molecular weight from 500 to 2000.

In the practice of the present invention, the aforementioned tackifying agents are employed in an amount sufficient to provide at least one major surface of the subject polymer films with an initial, as made cling value of at least 10 grams per 12.7 cm (5 inches) of sample width (preferably at least 15 grams per 12.7 cm of sample width) when measured according to the Cling Test Method described in conjunction with Example 1 of the hereinafter presented

working examples. Preferably, said tackifying agents are employed in an amount such that the resulting stretch/cling film retains the ability to cling to itself even when stretched in the machine direction to  
5 an elongation of 150 percent (most preferably even at an elongation of 200 percent) in the machine direction when used in conventional stretch/cling packaging or palletizing operations.

In actual practice, the amount of tackifying agent to be employed in the subject stretch/cling films and in order to accomplish one or more of the foregoing objectives will depend in large part upon the particular tackifying agent chosen for utilization therein, upon the manner in which said tackifying agent is distributed  
15 within or throughout said film, upon the surface characteristics (i.e., smoothness) exhibited by the polymer film concerned and upon the ultimate end-use application for which said film is intended. Thus, for example, in the case of films intended for stretch/cling wrap applications  
20 involving use at relatively low levels of elongation (e.g., meat wrap applications and the like), relatively lower levels of tackifying agent (e.g., as little as about 1 weight percent tackifying agent on a total film weight basis and based upon a homogeneously blended  
25 single layer film type structure) can typically be employed with suitable results. On the other hand, in the case of films intended for use at relatively high levels of elongation (e.g., in palletizing, bundling etc. operations) the utilization of tackifying agent  
30 at relatively higher levels (e.g., on the order of at least 3 weight percent on a total film weight basis and based upon a homogeneously blended single layer film structure) is typically required.



Naturally, since cling properties are predominantly a surface related phenomenon in films of the type involved herein, it will be recognized by those skilled in the art that the minimum required amount of tackifying agent usage can be reduced or minimized somewhat (i.e., in terms of the minimum weight percentage employed on a total film weight basis) by resort to an intentional non-homogeneous distribution of said tackifying agent within said film structure such as, for example, by utilization of known coextrusion techniques to concentrate said tackifying agent in a layer at one or both major surfaces of said film structure while keeping either one side, or a central core layer thereof substantially free of said tackifying agent. Thus, for example, in one preferred embodiment of the present invention the subject stretch/cling film is a multi-layer structure in which (A) a first ethylene/higher  $\alpha$ -olefin copolymer layer (a) constitutes at least 50 percent (preferably at least 70 percent) of the total film thickness and (b) has no significant quantity of tackifying agent incorporated therein and in which (B) at least one ethylene/higher  $\alpha$ -olefin copolymer surface layer has an effective amount (e.g., from 1.5 to 10, preferably from 3 to 8, weight percent based upon the weight of said surface layer) of the tackifying agent incorporated therein.

In another preferred embodiment, the foregoing multilayered structure is one in which said first tackifier free layer is a centrally located core layer which is sandwiched in between two tackifier containing surface layers.

Within the context of the foregoing film structure and end-use related variables, it can be said, however, that as a general rule the aforementioned tackifying agent will typically be employed  
5 in an amount ranging from 0.5 to 10 (preferably from 1 to 8) weight percent based upon the total weight of the subject polymer films.

An additional feature of some significance relative to the stretch/cling films of the present  
10 invention (and, in particular, relative to the requisite cling properties thereof) is that said films have relatively smooth surfaces. For the purposes of the present invention, adequate surface smoothness will preferably be evidenced by the film having 60° gloss  
15 rating of at least about 110 as measured using a Gardiner Glossimeter in the conventional fashion. Most preferably, the films of the present invention will exhibit a 60° gloss rating of at least 120 as measured using said Gardiner Glossimeter.

20 The thickness of the stretch/cling films of the present invention is not particularly critical. However, as a general rule the thickness thereof will typically be in the range of from 12.7 to 50.8 microns (0.5 to 2 mils) and will preferably be in the range  
25 of from 17.8 to 25.4 microns (0.7 to 1 mil).

In the preparation of the stretch/cling films of the present invention, it is believed to be important that said films be biaxially oriented in order that they possess the requisite MD tear strength and MD:TD  
30 tear strength ratio as set forth above. In addition, it is also believed to be important (for example, from the

standpoint of surface smoothness and requisite cling at tolerable tackifying agent loadings) that said films be quenched fairly rapidly following the extrusion thereof such as, for example, at a quench rate more characteristic  
5 of that of a conventional cast film process as opposed to the generally slower quench rate typically provided by conventional blown film manufacturing techniques.

While the foregoing combination of processing features may be suitably obtainable for the purposes of  
10 the present invention in a variety of known fashions (e.g., conventional cast film extrusion for rapid quench coupled with known tentering techniques for biaxial orientation and/or conventional blown film extrusion for biaxial orientation coupled with a  
15 subsequent water quench for rapid cooling), it has been found to be advantageous, and is preferred, for the purposes of the present invention to prepare the subject stretch/cling films using the film extrusion process and apparatus described and claimed in U.S.  
20 Patents 3,976,733 and 4,025,253.

As has been indicated hereinabove, the stretch/cling films of this invention are particularly well suited for use in stretch/cling packaging and/or palletizing applications which are well known in the  
25 art. Accordingly, the utilization of such films in said packaging and/or palletizing operations is generally pursuant to methodology and techniques which are well known to those skilled in the stretch/cling packaging and palletizing art. Similarly, the stretch/cling  
30 films of the present invention can also contain known additives which are commonly employed in conventional

stretch/cling film compositions such as, for example, pigments, dyes, opacifiers, antioxidants, U.V. stabilizers, and the like.

5 The present invention is further illustrated by reference to, but is not to be interpreted as being limited by, the following examples thereof in which all parts and percentages are on a weight basis unless otherwise indicated.

Example 1

10 A two-layer film having a total thickness of 20 microns (0.8 mil) was prepared using the film extrusion process described in U.S. Patents 3,976,733 and 4,025,253 at a blow-up ratio of 2.5:1 and a quench temperature of 30°C (86°F). The primary layer of said film constituted  
15 70 percent of the total film thickness and was composed of an ethylene/octene copolymer having a melt index of 2.3 decigram/min and a density of 0.917 g/cc and which is marketed by The Dow Chemical Company as DOWLEX\* 2047 brand linear low density polyethylene (LLDPE). The  
20 remaining layer of said film, constituting 30 percent of the total film thickness, was composed of a blend containing 95 weight percent, based on blend weight, of DOWLEX\* 2047 brand LLDPE and 5 weight percent, based on blend weight, of polyisobutylene as a tackifying agent.  
25 The properties of the resulting film product are summarized in Table I below. Also presented in Table I for comparative purposes are the corresponding properties of a commercially available stretch/cling film marketed as MOBILRAP® X by Mobil Chemical Corporation.

30 \* Trademark of The Dow Chemical Company

TABLE I

5	Film Properties	Film of Example 1	Commercially Available Comparison Film*
1	Elmendorf Tear (g/mil)		
	- Machine Direction	478	78
	- Transverse Direction	625	744
2	60° Gloss	140	125
10	3 Cling gr/12.7 cm** (gr/5 in)	24	5
	4 Shrink (negative value denotes shrink; positive value denotes elongation)		
15	- Machine Direction	-63.2	-85.4
	- Transverse Direction	+ 9.2	+51.3
5	Yield Tensile	psi kg/cm <sup>2</sup>	psi kg/cm <sup>2</sup>
	- Machine Direction	1311 92	2245 157
	- Transverse Direction	1046 73	1039 73
20	6 Ultimate Tensile	psi kg/cm <sup>2</sup>	psi kg/cm <sup>2</sup>
	- Machine Direction	4319 302	6297 441
	- Transverse Direction	3694 258	3900 273
	7 Ultimate Elongation (%)		
	- Machine Direction	650	500
25	- Transverse Direction	743	900

\* Not an example of the invention.

\*\* The reported cling value is the average force in grams required to peel apart or separate two 12.7 cm wide by 22.9 cm long (5 inch wide by 9 inch long) film samples which have been freshly stuck together, extruded tube outside surface to extruded tube inside surface, under the gravimetric pressure or force applied by rolling a cylindrical metal roller having a weight of 1 pound, a length of at least 12.7 cm (5 inches) and diameter of 0.48 cm (3/16 inches) a single pass over the entire width of said film samples (i.e., in a fashion such that the entire weight of said roller is supported by

5 and uniformly distributed over the entire width of  
said film sample as said roller passes thereover)  
and at least over that portion of the film sample  
length over which the average separation force is  
to be measured. In taking such cling value  
measurement, the peeling apart of the two film  
specimens is conducted at a constant peeling speed  
of 23 cm/minute (9 inches/minute) and a constant  
10 peel angle of 60°, said angle being measured  
between the top surface of the already peeled off  
portion of the top film sample layer and the top  
surface of the adjacent, yet to be peeled off  
portion of said top film sample layer.

Utilizing each of the foregoing films, stretch  
15 wrapping evaluations were conducted on commercial scale  
stretch wrapping equipment having a pre-stretch system.  
The test pallet employed in such evaluation was a  
plywood box having a height of 1.83 meters (72 inches),  
a width of 1.22 meters (48 inches) and a depth of 1.22  
20 meters (48 inches), said box being positioned on a  
typical wooden pallet. The evaluation consisted of  
determining the minimum film weight required for  
wrapping the box, defining the elongation at which the  
film's cling became inadequate, and defining the  
25 elongation at which the film could no longer maintain  
its integrity around the sharp corners and edges at the  
top of the box. The results of these tests are summar-  
ized in Table II below.

TABLE II

5	<u>Film Properties</u>	<u>Film of Example 1</u>	<u>Commercially Available Comparison Film</u>
	1 Minimum Weight (oz) gm	(4.0) 113	(5.8) 142
	2 Cling Elongation Limit (%)	240	100
	3 Corner Test		
10	- Maximum % Elongation	160	95
	- Film Weight on Wrapped	(7)	(8.3)
	Pallet (oz) gm	198	235

As can be seen from the results presented in Tables I and II, the film of Example 1 is clearly superior to the commercially available comparison film in terms of its (a) machine direction Elmendorf tear strength; (b) machine direction:transverse direction Elmendorf tear strength ratio; (c) its initial cling strength and (d) its maximum elongation limit based both upon loss of cling properties and upon corner puncture criterion.

#### Comparative Experiment

Following the procedures of Example 1, a film sample like that of Example 1 was prepared except that the ethylene/octene copolymer component of Example 1 was replaced in both film layers with a blend composed of 95 weight percent of that same ethylene/octene copolymer and 5 weight percent of a conventional low density polyethylene homopolymer having a density of 0.922 g/cc and a melt index 1.15 decigrams/minute. The resulting film specimen had a machine direction Elmendorf

tear strength of 117 g/mil and a machine direction:  
transverse direction Elmendorf tear strength ratio of  
0.176. Thus, the results of this comparative experiment  
clearly illustrate the importance of ensuring that the  
5 ethylenic polymer component employed in the present  
invention consists essentially of an ethylene/higher  
 $\alpha$ -olefin polymer as indicated hereinabove.

While the present invention has been herein-  
described and illustrated by reference to certain  
10 specific embodiments and examples thereof, such fact is  
not to be understood as limiting the scope of the  
presently claimed invention.



1. A stretch/cling film (A) having (a) an Elmendorf tear rating in the machine direction of at least 250 g/mil; (b) a machine direction:transverse direction Elmendorf tear ratio of at least 0.5; and (c) a cling value of at least 10 grams per 12.7 cm (5 inches) of sample width and (B) being composed of an olefin polymer composition consisting essentially of (a) an ethylenic copolymer comprising, in polymerized form, a major proportion of ethylene and a minor proportion of a higher  $\alpha$ -olefin monomer containing 6 or more carbon atoms and (b) an effective amount of a tackifying agent.

2. The stretch/cling film of Claim 1 which is further characterized by retaining the ability to cling to itself even when stretched to an elongation of 150 percent in the machine direction.

3. The stretch/cling film of Claim 1 which is further characterized by retaining the ability to cling to itself even when stretched to an elongation of 200 percent in the machine direction.

4. The stretch/cling film of Claim 1 which has a machine direction:transverse direction Elmendorf tear ratio of at least 0.6.

5. The stretch/cling film of Claim 1, wherein the tackifying agent is employed in an amount of from 0.5 to 10 weight percent based on the total weight of the olefin polymer composition.

6. The stretch/cling film of Claim 5 wherein the tackifying agent is employed in an amount equal to or less than 1.5 weight percent based upon the total weight of said olefin polymer composition.

7. The stretch/cling film of Claim 1 wherein the tackifying agent is polyisobutylene.

8. The stretch/cling film of Claim 1 wherein the higher  $\alpha$ -olefin monomer of the ethylenic copolymer is a  $C_6$  to  $C_{12}$   $\alpha$ -olefin.

9. The stretch/cling film of Claim 1 wherein the higher  $\alpha$ -olefin monomer component constitutes from 2 to 10 weight percent of said ethylenic copolymer.

10. The stretch/cling film of Claim 1 which is further characterized by being composed of (A) a first polymer layer which constitutes at least about 50 percent of the total thickness of said stretch/cling film and which has no significant quantity of any tackifying agent incorporated therein and (B) at least one surface layer which has an effective amount of said tackifying agent incorporated therein.

11. The stretch/cling film of Claim 10 wherein said tackifying agent constitutes from 1.5 to 10 percent by weight of said surface layer.

12. The stretch/cling film of Claim 10 which comprises two surface layers having an effective amount of a tackifying agent incorporated therein and wherein said first polymer layer constitutes a core layer sandwiched between said two surface layers.

13. The stretch/cling film of Claim 10 wherein said tackifying agent constitutes from 3 to 8 percent of the weight of said surface layer.



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Applicant: **THE DOW CHEMICAL COMPANY**, Dow Center 2030 Abbott Road Post Office Box 1967, Midland Michigan 48640 (US)

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Inventor: **Mientus, Bernard S.**, 880 Truman Court, Newark Ohio (US)  
Inventor: **Fields, William G.**, 590 Deanna Stroll, Heath Ohio (US)  
Inventor: **Bussey, Marlin G.**, 338 Deer Trail Drive, Thornville Ohio (US)

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Representative: **Hann, Michael, Dr. et al**, Patentanwälte Dr. Michael Hann Dr. H.-G. Sternagel Marburger Strasse 38, D-6300 Giessen (DE)

**Olefin polymer stretch/cling film.**

Olefin polymer films composed essentially of a copolymer of a major proportion of ethylene with a minor proportion of a higher  $\alpha$ -olefin monomer and an effective amount of a tackifying agent are provided which have unusually high Elmendorf tear strength in the machine direction, a good balance of machine direction to transverse direction Elmendorf tear strengths, and excellent cling properties. Such films are exceptionally well suited for use as a stretch/cling film in various packaging and palletizing applications.

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# EUROPEAN SEARCH REPORT

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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. <sup>3</sup> )
A	FR-A-2 277 852 (EXXON RESEARCH)		C 08 J 5/18 B 32 B 27/18
A	EP-A-0 011 930 (C.I.L.)		
A	DE-A-2 362 049 (ESSO RESEARCH)		
			TECHNICAL FIELDS SEARCHED (Int. Cl. <sup>3</sup> )
			C 08 J C 08 L
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 17-07-1984	Examiner VAN GOETHEM G.A.J.M.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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